We have enhanced the ability of a widely used watershed model, Hydrologic Simulation Program — FORTRAN (HSPF), to predict low flows by reconfiguring the algorithm that simulates groundwater discharge. During dry weather periods, flow in most streams consists primarily of base flow, that is, groundwater discharged from underlying aquifers. In this study, HSPF's groundwater storage-discharge relationship is changed from a linear to a more general nonlinear relationship which takes the form of a power law. The nonlinear algorithm is capable of simulating streamflow recession curves that have been found in some studies to better match observed dry weather hydrographs. The altered version of HSPF is implemented in the Chesapeake Bay Program's Phase 5 Model, an HSPF-based model that simulates nutrient and sediment loads to the Chesapeake Bay, and is tested in the upper Potomac River basin, a 29,950 km2 drainage area that is part of the Bay watershed. The nonlinear relationship improved median Nash-Sutcliffe efficiencies for log daily flows at the model's 45 calibration points. Mean absolute percent error on low-flow days dropped in five major Potomac River tributaries by up to 12 percentage points, and in the Potomac River itself by four percentage points, where low-flow days were defined as days when observed flows were in the lowest 5th percentile range. Percent bias on low-flow days improved by eight percentage points in the Potomac River, from -11 to -3%.